HVW Technologies
Infra-Red Object Detection System (IRODS™)

Overview

IRODS™ is a low-cost, short-range Infra-Red (IR) alternative to ultrasonic detection systems. By setting a detection distance threshold via a tiny potentiometer, the user can reliably detect the presence of any object that comes within that distance. Usable detection range is 10 cm to 80 cm (approx. 4" to 31.5").

The IR Object Detection System consists of the Sharp GP2D05 Distance Measuring Sensor and a custom cable assembly. The GP2D05 is a compact, self-contained IR object detection system incorporating an IR transmitter, receiver, optics, filter, detection, and amplification circuitry. The unit is highly resistant to ambient light and impervious to variations in the surface reflectivity of the detected object.

Unlike many IR systems, IRODS™ has a fairly narrow field of view; making it ideal for sensing even small objects such as candlesticks. The field of view changes with the threshold distance (see the graph at the end of this document), but is no wider than 10 cm (5 cm either side of centre) when set at maximum range.

Specifications

ABSOLUTE MAXIMUM RATINGS (Ta=25 °C, Vcc= 5V)

Parameter	Symbol	Rating	Unit
Supply Voltage[1]	V_{cc}	-0.3 to + 10	V
Input Terminal Voltage[2]	V_{in}	-03. To + 3	V
Output Terminal Voltage	V_o	-0.3 to + 10	V
Operating Temperature	T_{opr}	-10 to + 60	°C
Storage Temperature	T_{stg}	-20 to + 70	°C

NOTES:

1. The *operating* voltage of the unit is 4.4 – 7 VDC and **should normally be run on 5 VDC**
2. The input terminals maximum voltage rating is **3 V**. Exceeding this level may cause **permanent damage**.

ELECTRO-OPTICAL CHARACTERISTICS (Ta=25 °C, Vcc=5V)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Distance Measuring Range	ΔL	-	10	-	80	cm
Output Terminal Voltage	V_{OH}	Note 1	Vcc-0.3	-	-	V
	V_{OL}	Note 2	-	-	0.3	
Average Supply Current	I_{cc}	Note 3	-	10	22	mA
Standby Supply Current	I_{ccoff}	Note 4	-	3	8	µA
Vin Terminal Current	I_{vin}	Vin=0V	-	-160	-270	µA

Notes: 1) Output HIGH
2) Output LOW
3) Average current during measurement period (56 ms MAX.)
4) Current consumption when Vin terminal is HIGH

Mounting the Sensor

The sensor unit may be mounted using the included piece of double-sided foam, or 2 appropriately-sized screws.

Connecting to the Sensor

A custom cable assembly is included with the IRODS™ kit. The miniature connector is keyed so that it may only be inserted one way. The following table shows the necessary connections:

Pin	Symbol	Wire Colour	Connect To
1	V_{in}	Green	Voltage divider going to microcontroller pin (**MAX. 3.0 Volts !**)*
2	GND	Black	Ground
3	V_{out}	Blue	Input pin of microcontroller
4	V_{cc}	Red	+ 5 V DC

*The maximum voltage the input can tolerate is 3 V. Use two 1K resistors (included) to make a voltage divider (fig. 1)

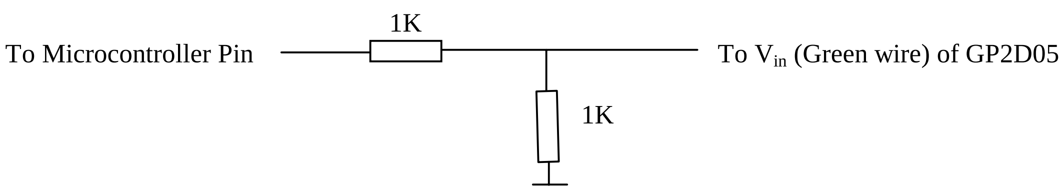

Fig. 1.

Calibration

To calibrate the unit to the desired threshold distance, carefully turn the small potentiometer (next to the connector) with a jeweller’s screwdriver. CAUTION: The potentiometer is delicate; use a screwdriver with a very small blade and make adjustments with the least amount of pressure you can -the sensor was not designed to be adjusted continuously, so try to set the distance once and leave it. To set the threshold distance closer, turn the pot counter-clockwise. To set it farther, turn it clockwise. The amount that the potentiometer must be turned for a particular change in threshold setting is very small; $1/64^{th}$ of 1 turn will produce a noticeable change. Note that turning the potentiometer during a measurement sequence will invalidate the result. Therefore, you must cause a single measurement sequence, adjust the pot, then initiate another sequence. A program suitable for calibrating the unit is shown below.

Operation

The GP2D05 makes repeated measurements before it indicates the presence (or absence) of an object. The time it takes to make these measurements varies slightly from unit to unit and can be from 28 ms to a maximum of 56 ms. We recommend that you allow the full 56 ms, just to be safe. If you have a time-sensitive application, you should experiment with the specific unit(s) you have to determine the minimum reliable measurement time. The following 4 steps illustrate a detection cycle:

1. The V_{in} line is normally held HIGH (+3V). To begin a measurement sequence, pull this line LOW (0V).
2. Wait 56 ms.
3. Scan the V_{out} line’s status. If it is LOW, an object was detected within the threshold distance. If it is still HIGH (+5V), no object was detected.
4. Raise the Vin line (back to +3V) for a minimum of 1 ms (3 ms recommended) before beginning the next measurement sequence. This resets the V_{out} register within the GP2D05. Since the result remains until explicitly cleared, the host microcontroller need not have interrupt capability since the result will wait until the micro has time to read it.

IMPORTANT NOTE: The output of the GP2D05 will float when not asserted. It is good practice to use a weak pull-up resistor (10K Ohm) to +5V on the output (blue wire). If you experience erratic readings, it is most likely that the floating output is causing the micro to 'see' objects that don't exist.

Example

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'Measurement and Calibration Routine for IRODS™ using a BASIC Stamp II
'P0 is connected to the voltage divider, which in turn goes to Vin (green wire)
'P1 is connected to Vout (blue wire)

START: High 0                          'Make sure that Vin sees a high-low transition
       Pause 3                         'Wait for it to be seen
       Low 0                           'Begin measurement sequence
       Pause 56                        'Wait for measurement sequence to complete
       If IN1=0 Then SHOW              'If object detected, tell me
       Goto START                      'No object detected, start over
SHOW:  Debug "Object Detected", cr     'Display "Object Detected" in debug window
       Pause 5000                      'Wait 5 seconds (remove when done calibrating)
       Goto START                      'Start over
       END
```

Using Multiple Sensors

In order to minimize the number of I/O lines required, we suggest that when using multiple sensors, that the V_{in} lines be connected together and brought to a single output pin on the micro. This means that all sensors will start measuring at the same time but you will only need 1 input per sensor, plus 1 output to start them all. Using this techniques, an effective obstacle avoidance system for a mobile robot, such as our Mobile Robotics Platform (MRP), can be implemented using only 3 I/O lines (for 2 sensors). Since the V_{in} line draws only microamps, many sensors can be connected like this.

Some Observations on the Effect of Different Kinds of Light

Ambient Light

Tests have shown the GP2D05 to be highly immune to ambient light levels. Incandescent, fluorescent, and natural light don't appear to bother it. The only instance where we were able to get it to falsely trigger was when a flashlight was pointed *directly* into the sensor's receiver; even a few degrees off-centre is enough for the sensor to ignore it.

IR Light

The GP2D05 uses a modulated IR beam to guard against false triggering from the IR component of incandescent, fluorescent, and natural light. Tests with several kinds of IR remote controls have shown that even with 2 or 3 remotes pointed at the GP2D05, the unit still functions normally.

Laser Light

Tests with a laser pointer had results similar to the flashlight; only a beam aimed straight into the sensor's receiver would cause a false reading. If the beam comes from even a few degrees off-center, it has no effect.

How Does it Work ?

Figure 2 shows how the GP2D05 uses an array of photodiodes (called a Position Sensitive Detector, or PSD) and some simple optics to detect distance. An infra-red diode emits a modulated beam; the beam hits an object and a portion of the

light is reflected back through the receiver optics and strikes the PSD. In figure 2, Object A is closer and therefore the reflected light from it enters the receiver's lens at a greater angle than does light from object B.

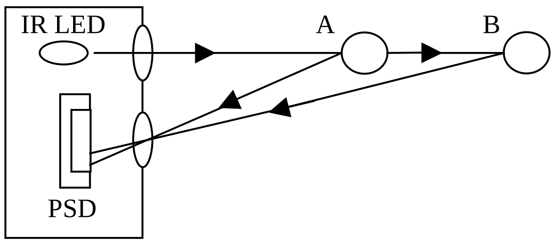

Fig. 2.

Here, Object A is at the limit of the PSD's range (about 10 cm away). Notice how that if it were any closer, the light would not hit the PSD at all. Similarly, if B were moved farther away, its' light would eventually go past the 'top' of the PSD and would not be seen either (at about 80 cm). This explains why IRODS™ has these limits

Think of the PSD as a resistor with a large number of taps (wires coming out at various points along the resistor). When light hits the PSD, it hits one of the 'taps' and causes current to flow out each end of the resistor, forming a voltage divider similar to that of figure 1. As an object moves closer or farther from the sensor, incoming light hits a different 'tap' causing the current coming out each end of the resistor to change. These currents are compared and a voltage proportional to the position of the 'tap' (and hence the distance of the object) is generated. This voltage is compared with the voltage that you set with the threshold pot to determine whether the V_{out} line should be sent low. A block diagram of the inner workings of the GP2D05 can be found at the end of this document.

CAUTION: The GP2D05 is a precision device. **DO NOT** attempt to open the unit. Doing so will ruin the delicate alignment of the optics.

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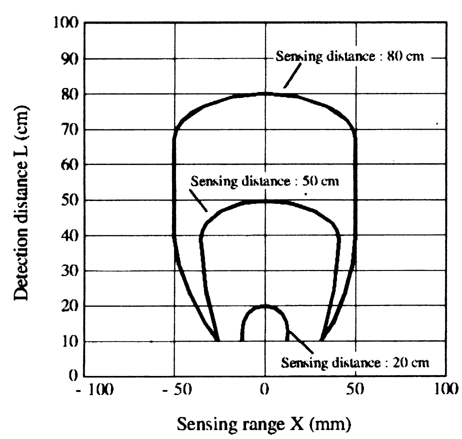
Detection Distance vs. Sensing Range



■ Outline Dimensions (Unit : mm)